GOES-R AWG Product Validation Tool Development

Aerosol Detection Product Team

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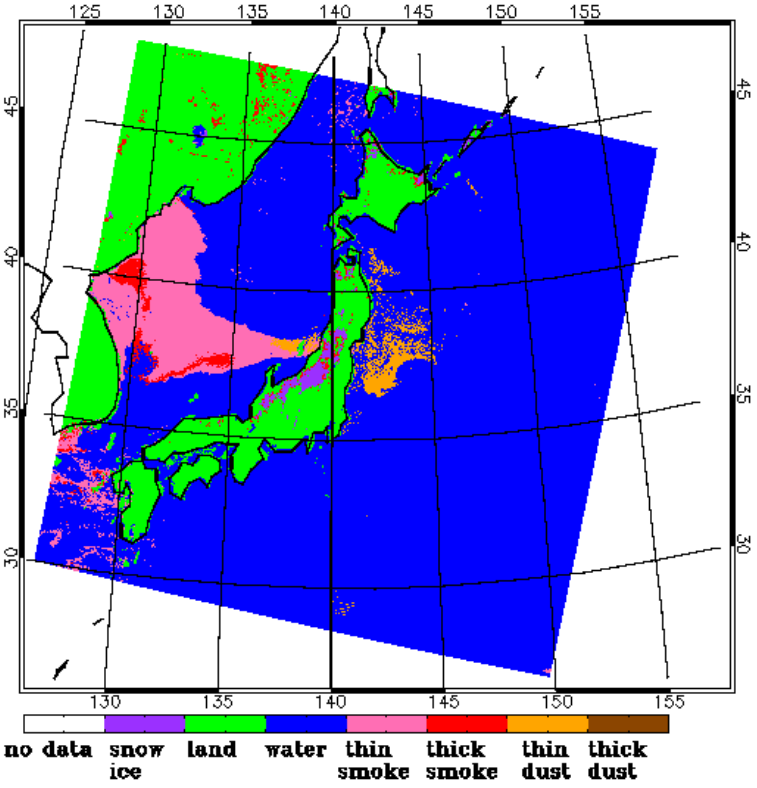
Products

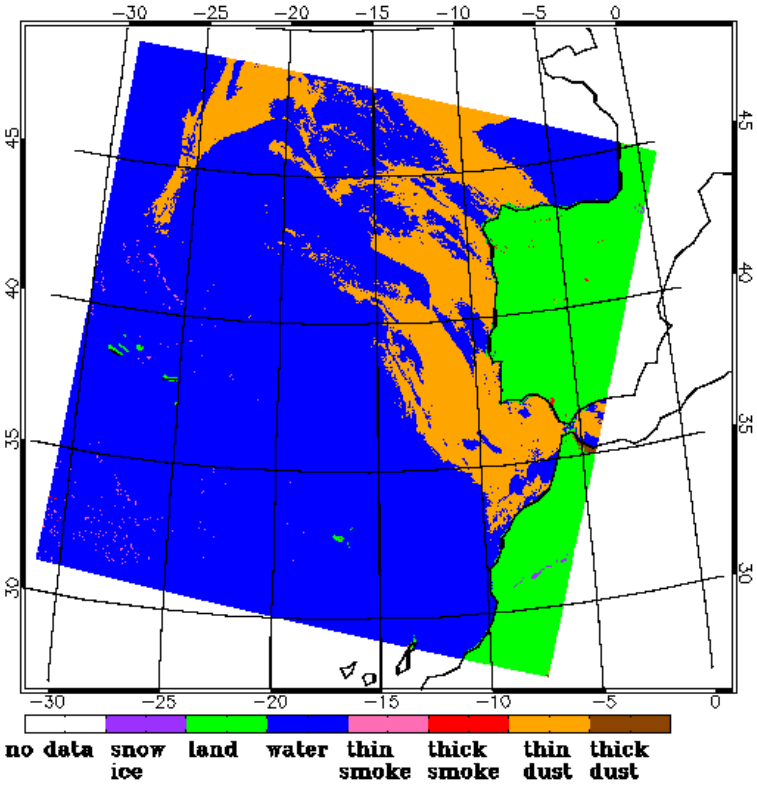
Smoke over eastern Asia

04/13/2011



Dust plume over western Europe

04/07/2011



Requirements

- Accuracy for smoke
  - 80% over land
  - 70% over water
- Accuracy for dust
  - 80% over both land and water
- Other performance metrics
  - Probability of detection
  - False alarm rate

Validation Strategies

- Product is qualitative in nature. So finding "truth data" is not that straight forward. Therefore strategy is:
  - to use what ever coincident other similar satellite data exist. These are:
    - CALIPSO Vertical Feature Mask (VFM)
    - OMI (OMPS in the future) Aerosol Index product (positive for dust and smoke)
  - to infer the presence of smoke and dust in the atmosphere using *in situ* observations and use the data. These are:
    - AERONET Angstrom Exponent (itself an un-validated product)
    - IMPROVE speciated aerosol measurements (daily average)
    - Visual inspection of GOES-R ABI RGB imagery (same temporal scale as dust/ smoke detection – For internal consistency check for diagnosing issues and may not be released to public.
    - SEARCH speciated aerosol measurements (hourly)
    - Hazard Mapping System (HMS) fire and smoke analysis
    - Field campaign data during which visual reports of dust and smoke, if they exist
  - Compare aerosol model (type) identified by GOES-R ABI Suspended Matter/AOD algorithm for qualitative comparison and assigning a quality flag that indicates the mis-match - For internal consistency check for diagnosing issues and may not be released to public

Validation Methodology (1)

- How to look for artifacts and spurious signals in the data?
  - Routine validation on a statistically significant samples may hide some data artifacts that may occur only certain times of the day or season or year and so forth. Some examples:
    - High solar zenith angle
    - Certain viewing geometries
    - Water over land
    - Changing seasons that has an impact on surface characteristics
    - Instrument problems (e.g., a particular channel degradation)
    - Etc.
  - To catch these artifacts, we have to employ visual inspection of the product from time to time or rely on the user to report back to product developers on the artifacts. For example, with current GOES aerosol product, five years after it was declared operational, we have found several issues that continue to pop up. Lessons learned from that experience tells us that we should do a thorough check of ancillary data files, calibration updates, geo-location information etc. if they are applicable to GOES-R

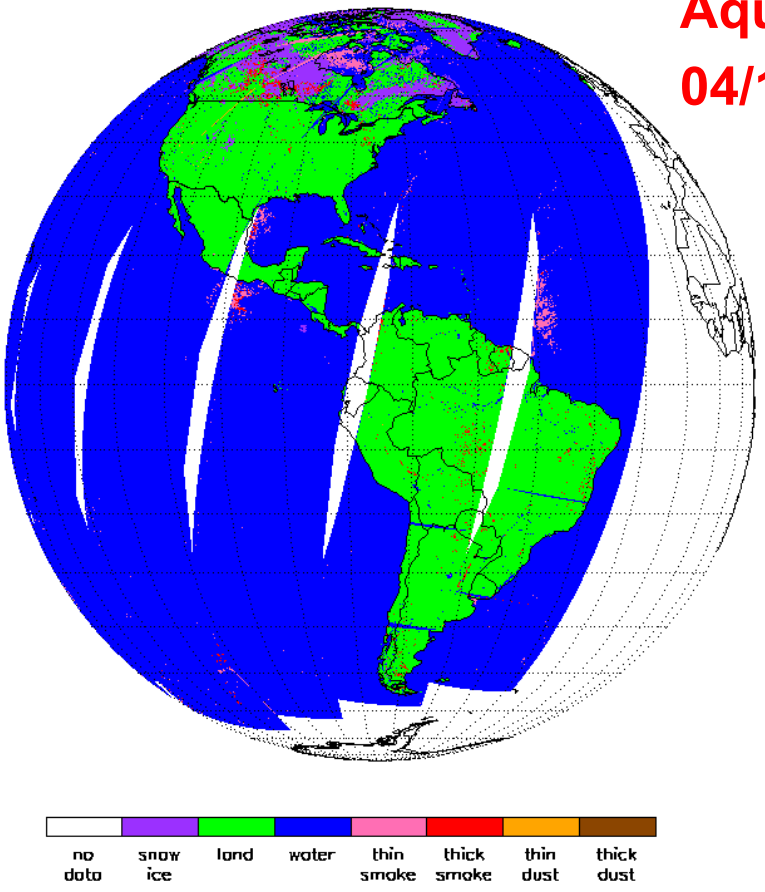
Validation Methodology (2)

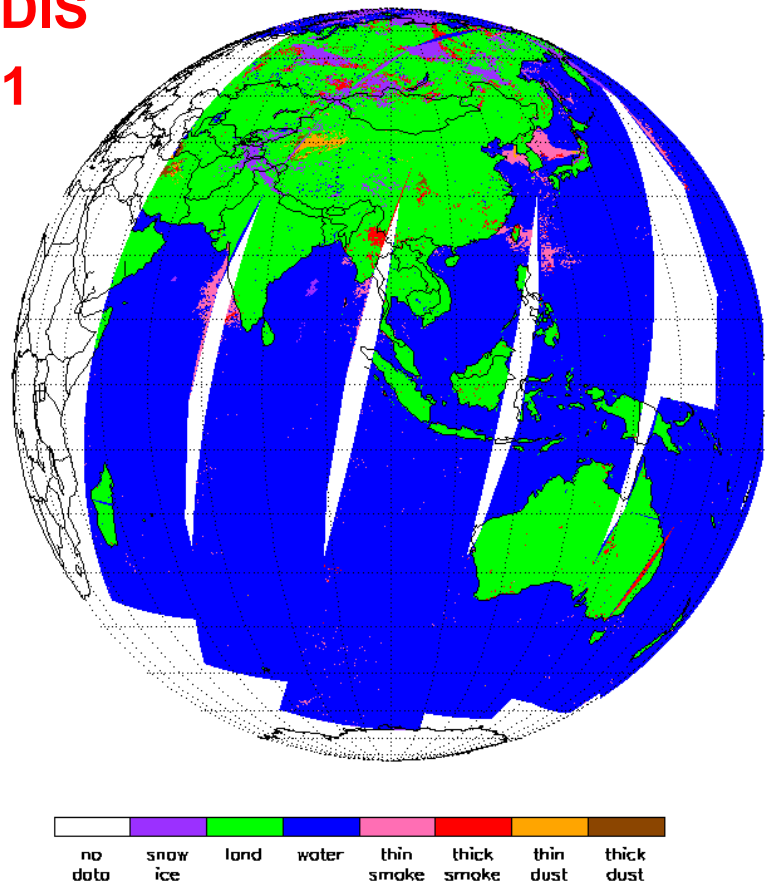
- Temporal and spatial matching of ABI retrievals with truth data. Matchup criteria could vary depending on the type of the truth data.
- Typically, ABI retrievals around a threshold ± min of observational time window of truth data will be averaged and matched up with the truth data. Spatially, different scales could be used. For example, spatial average of ABI product could be computed depending on the validation purpose (e.g., routine vs. deep dive).
- For example, comparing ABI smoke/dust flag to CALIPSO, we employ 5 km X 5 km box around CALIPSO footprint and any available retrievals from ABI (even if it is only one 1 km pixel) are used in comparison.
- Similarly, if ABI retrievals are not available when *in situ* observations are available, then we expand the time window threshold.
- Experience with MODIS data has shown that, some thick smoke and/or dust clouds are identified as clouds. We need to carefully evaluate the aerosol product for artifacts due to clouds mis-identified as aerosol or vice-versa.

Routine Validation Tools

- ABI Data Processing: using global MODIS Level-1b as near real-time (2 weeks delay) proxy data, we generate smoke/dust aerosol detection product.

Aqua/MODIS
04/13/2011

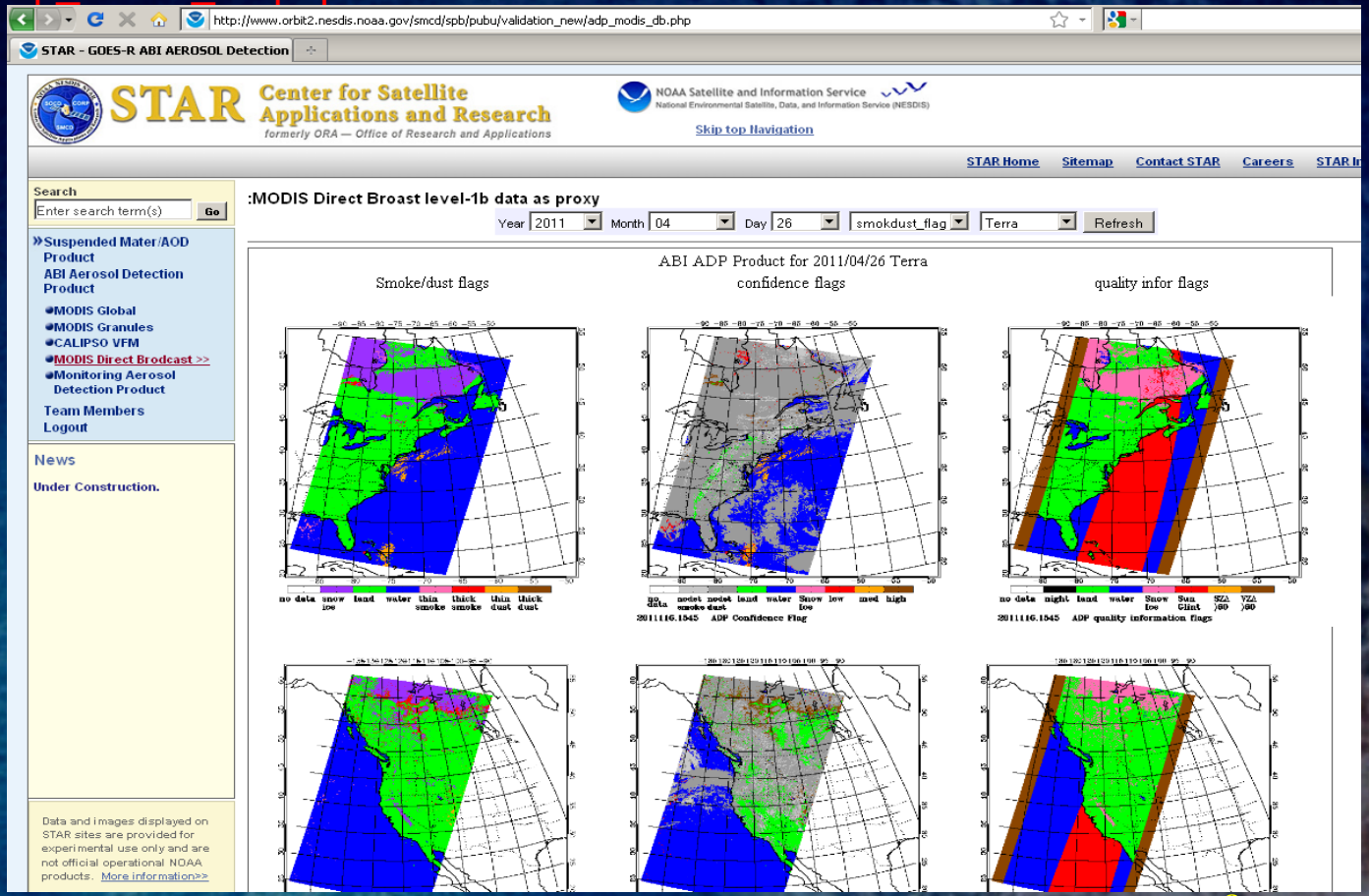




Routine Validation Tools

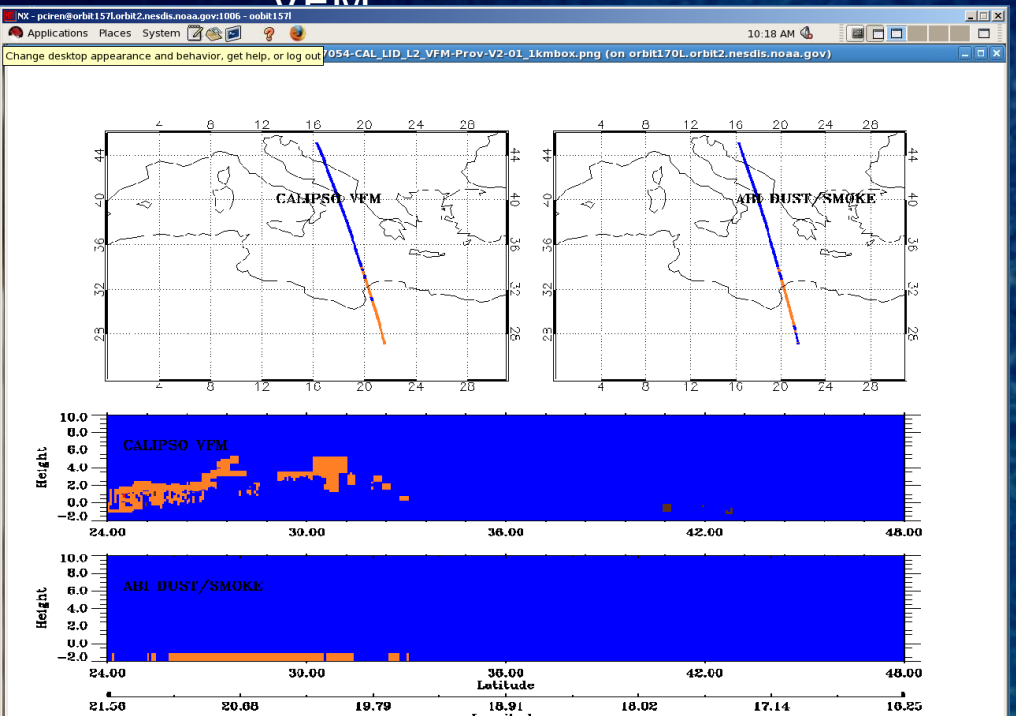
- ABI data processing: using MODIS direct broadcast data as real-time (1 day delay) proxy data http://www.orbit2.nesdis.noaa.gov/smcd/spb/pubu/validation_new/adp_modis_db.php

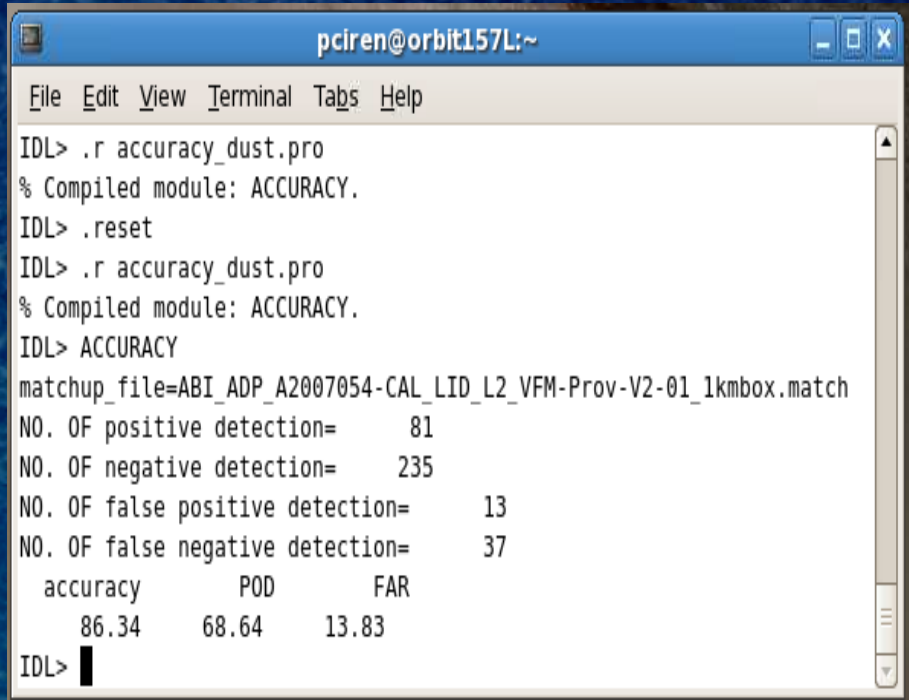
Products and various quality flags are displayed on a webpage



Routine Validation Tools

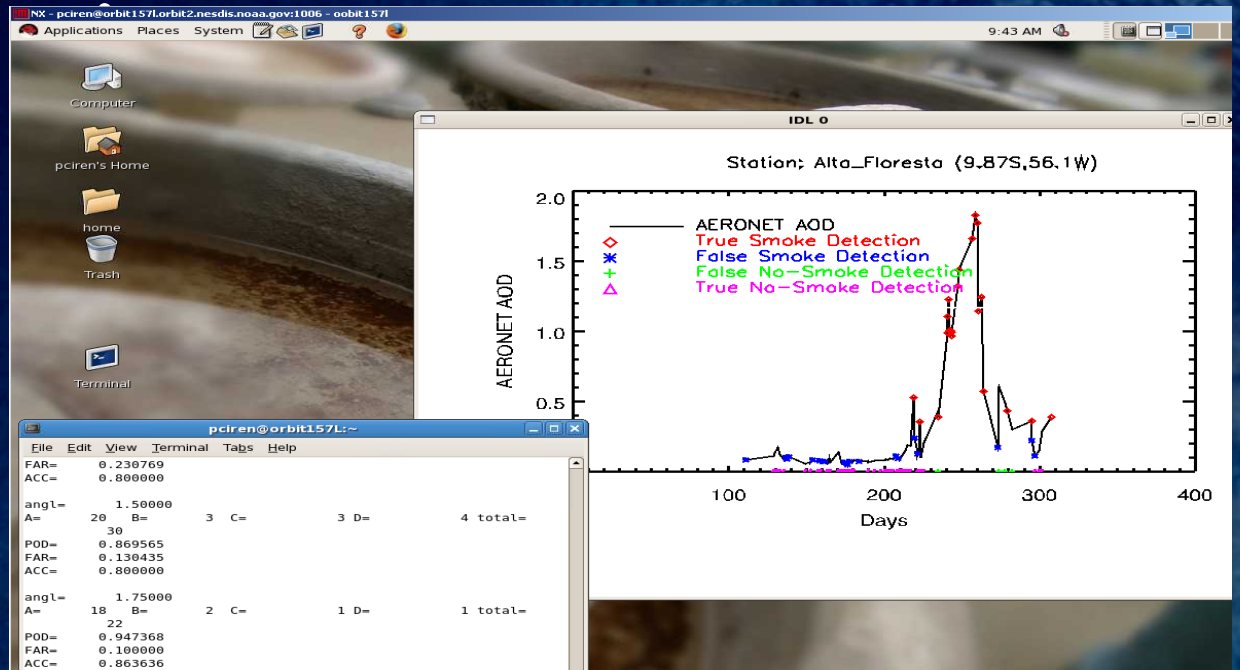
- Product validation: using CALIPSO Vertical Feature Mask (VFM) as truth data (retrospective analysis not near real time. Data downloaded from NASA/ LaRC)
- Tools (IDL)
  - Generates match-up dataset between ADP and VFM along CALIPSO track, spatially (5 by 5 km) and temporally (coincident)
  - Visualizing vertical distribution of VFM and horizontal distribution of both ADP and VFM





Routine Validation Tools

- Using AERONET observations (L1.5) available from NASA
  - a. AOD
  - b. Angstrom exponent (representing aerosol type: smoke or dust)
- Tools (IDL):
  - Matchup tool to collocate ADP with AERONET in both space (50 by 50 km) and time (±30 minutes)
  - Visualizing the match-up dataset and generating statistics matrix:



Statistics from Routine Validation Tools

- Scripts will be written to automatically look for updates on the availability of truth data for download.
- Primary statistics will be generated from collection of the available truth data and ABI retrievals separately over land and water:
  - Accuracy
  - Probability of Detection
  - False Alarm Ratio
- Statistics that are generated on a daily or weekly time scale will be aggregated to generate time series. Time series can show sudden jumps in data quality or some kind of systematic behavior to the statistics. Anomalies will be identified for deep dive analysis

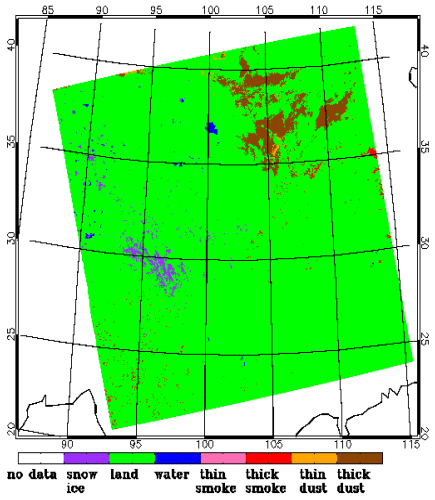
Deep-dive Analysis

- What constitutes “deep dive analysis”
  - (1) identify if change in product behavior coincides with algorithm update or calibration update or LUT update etc.
  - (2) manual inspection of imagery and channel reflectances/brightness temperature differences
  - (3) check for issues with cloud mask, snow/ice mask
  - (4) run backup algorithms if needed
  - (5) bring in validation data to check if anomalies exist in validation data as well. The validation data can be routine data or some specialized data that are available.
  - (6) use ancillary data sources such as aerosol model fields (if available) or human analysis (e.g., Hazard Mapping System) to see if analysts are observing similar anomalous behavior in retrievals.

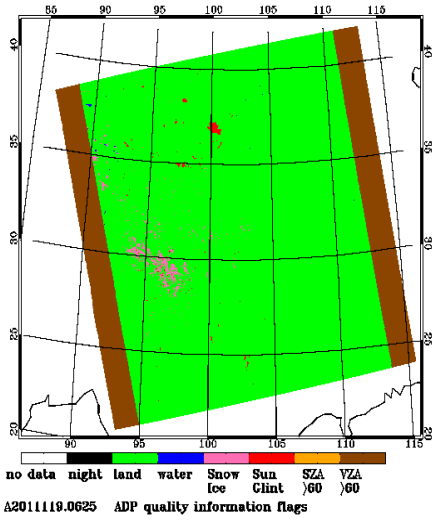
"Deep-Dive" Validation Tools

- Tools (IDL): Display all quality flags to identify issues with algorithm dependency variables such as cloud mask, snow/ice mask, fire mask, etc.

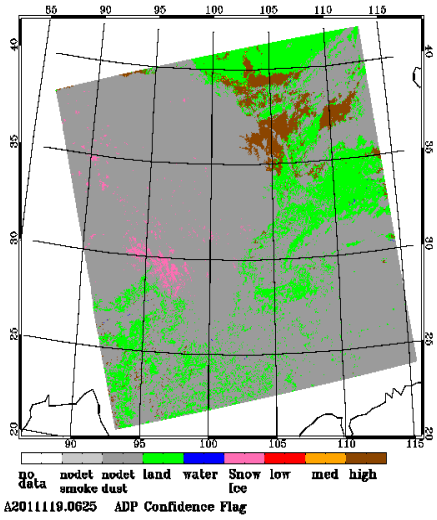
Smoke/dust flag



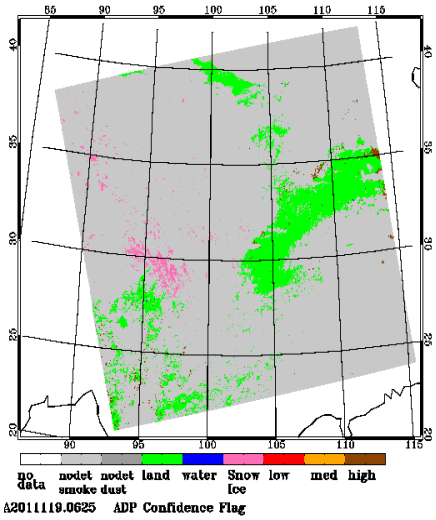
Quality infor. flag



Dust Determination



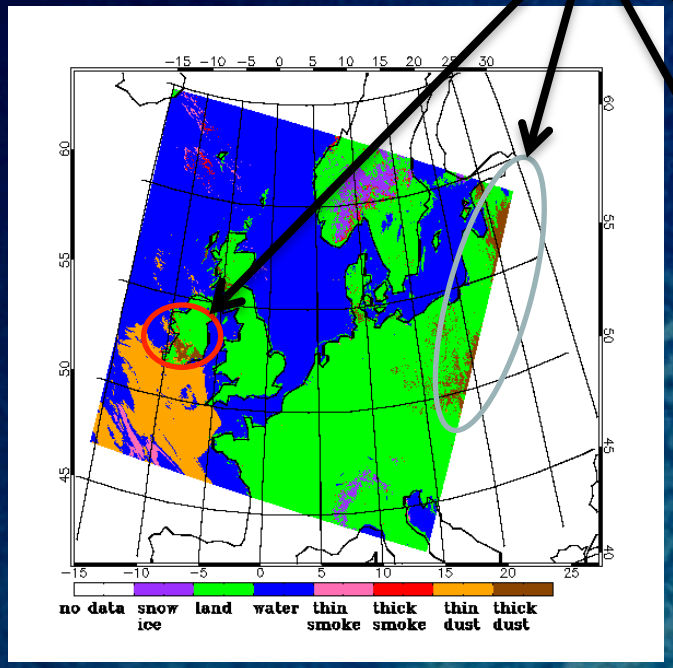
Smoke determination

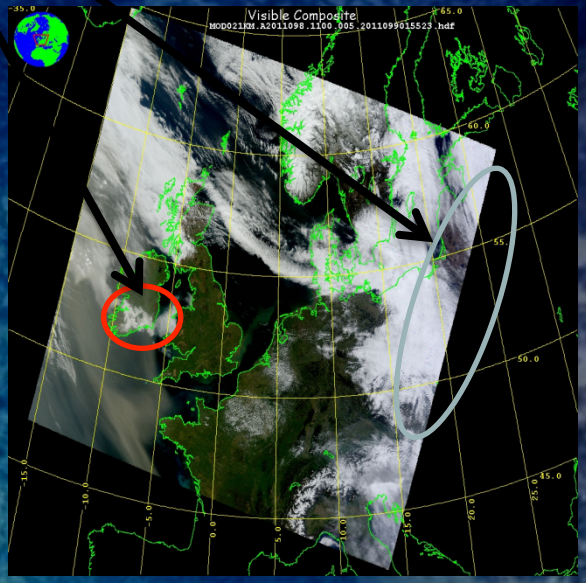


"Deep-Dive" Validation Tools

Example of a case when to do deep-dive analysis

False alarms due to mis-identifying of clouds as dust and smoke





Ideas for the Further Enhancement and Utility of Validation Tools

- Code review of all validation tools to ensure there is no “hard coding”
- If validation codes are translated into a different language or a widget is added, testing must be done to make sure coding changes do not affect the validation results

Summary